Sensor Assembly

Background of the Invention

1. Field of the Invention

The present invention relates to a sensor assembly, in particular to the assembly of a sensor comprising a plurality of textile layers.

2. Description of the Related Art

A fabric sensor comprising a plurality of conductive textile layers is described in international patent publication WO 00/072239.

A factor in the particular construction of a sensor utilising conductive textile layers is the prevention of unwanted electrical contact within the sensor, for example resulting from insufficient separation between conductive layers or from frayed edges of a conductive textile layer.

A further example of a mechanical contact apparatus and a method of production is described in United Kingdom patent publication GB 2 386 339 A. According to the method of production described in this publication, individual layers are brought together in a stack arrangement to form an assembly, whereafter a sealing process is performed during which the edges of the assembly are encapsulated within an applied material.

Brief Summary of the Invention

According to a first aspect of the present invention there is provided a sensor comprising a plurality of layers, comprising a first mask layer; a second mask layer; a third mask layer disposed between said first and

second mask layers and defining an aperture; and a first conductive layer disposed between the first mask layer and the third mask layer; a second conductive layer disposed between the second mask layer and the third mask layer; and a separator layer extending across the aperture in the third mask layer, said separator layer being configured to separate the first and second conductive layers when no pressure is applied to the sensor and to allow electrical contact between said first and second conductive layers during a mechanical interaction with said sensor, wherein each mask layer is formed from an electrically insulating material and has at least one side attached to another of said mask layers by adhesive.

According to a second aspect of the present invention the sensor further comprises a conductive track for applying electrical potentials to said first conductive layer, wherein a portion of said conductive track is disposed directly on said first mask layer and a portion is positioned directly on the conductive layer.

According to a third aspect of the present invention the conductive layers of the sensor comprise conductive textile layers.

According to a fourth aspect of the present invention the mask layers of the sensor are formed from a plastics material.

According to a fifth aspect of the present invention the adhesive is a thermoplastic adhesive.

According to a sixth aspect of the present invention the separator layer of the sensor is formed from a mesh material.

According to a seventh aspect of the present invention there is provided a method of assembling a plurality of layers to form a sensor

comprising, the steps of: obtaining a first mask layer and second mask layer; obtaining a third mask layer defining an aperture and formed from an electrically insulating material; locating a first conductive layer between the first mask layer and the third mask layer; locating a second conductive layer between the third mask layer and the second mask layer such that the third mask layer is disposed between said first and second mask layers, and attaching at least one side of each mask layer to another of said mask layers by adhesive, wherein a separator layer is located between said first and second conductive layers such that it extends across the aperture in the third mask layer, and wherein said separator layer is configured to separate the first and second conductive layers when no pressure is applied to the sensor and to allow electrical contact between said first and second conductive layers during a mechanical interaction with said sensor.

Brief Description of the Several Views of the Drawings

Figure 1 is a flow chart illustrating an assembly order for layers of a sensor.;

Figure 2 shows an exploded view of component layers of a sensor having layers in the order of the layer assembly order of *Figure 1*;

Figure 3 illustrates two subassemblies of the sensor of *Figure 2*;

Figure 4 illustrates an assembly technique of the component layers of the sensor of *Figure 2*.

Written Description of the Best Mode for Carrying Out the Invention

Figure 1

Figure 1 is a flow chart illustrating an assembly order for layers of a sensor. In this example, the sensor is configured to generate signals in response to mechanical interactions, the signals representing X-axis and Y-axis co-ordinate data of mechanical interactions within the sensing area of the sensor. European patent publication no. EP 0 989 509 describes a sensor and electrical arrangement allowing the sensor to detect both the position of a mechanical interaction within the sensing area (X-axis and Y-axis data) and also an additional property of the mechanical interaction, for example the extent or pressure of the mechanical interaction (Z-axis data).

At step **101**, a first mask layer (base mask) is positioned to receive further layers thereon. At step **102**, a first conductive textile layer is placed upon the first mask layer (base layer). At step **103**, first conductive tracking is located upon the first conductive textile layer. At step **104**, a second mask layer (intermediate mask) is positioned over the first conductive textile layer and first conductive tracking, as described in further detail below with reference to *Figure 2*. At step **105** a partially insulating mesh separator layer is located upon the second mask layer (intermediate mask). At step **106** a second conductive textile layer is placed over the mesh separator layer and at step **107** second conductive tracking is located upon the second conductive layer. At step **108** a third mask layer (top mask) is positioned over the second conductive textile layer and second conductive tracking to complete the layer assembly. In alternative orders of layer assembly, the conductive tracking may be laid down before or after the adjacent conductive textile layer.

Figure 2

An example of a sensor having layers in the order of the layer assembly order of *Figure 1* is shown in *Figure 2*.

Figure 2 shows an exploded view of component layers of a sensor **201**. Sensor **201** comprises three mask layers **202**, **203** and **204**. Each of these layers is fabricated from a polyurethane material coated on one side with a thermoplastic adhesive. Suitable material is sold under the trade mark Nylemark by Victory Designs Limited UK. Preferably, the melting point of the thermoplastic is within the range fifty degrees Celsius (50°C) to one hundred and fifty degrees Celsius (150°C), more preferably approximately one hundred and twenty degrees Celsius (120°C).

Top mask **202** and base mask **204** are continuous layers of substantially the same dimensions and at least these two mask layers have an electrical connection mounting tab, for example tab **205** of mask layer **202**. Intermediate mask **203** defines an aperture, or window, and has smaller dimensions in both axes than both top mask **202** and base mask **204**.

Sensor **201** comprises two conductive textile layers, **206** and **207**, which in this example are of substantially the same construction. The conductive textile layers **206**, **207** have electrically conductive fibres incorporation therein. Preferably, these conductive textile layers **206**, **207** have a woven or knitted construction but may have a felt or other non-woven construction, or a composite construction. The electrically conductive fibre may be for example, carbon coated fibre or carbon impregnated nylon 6 fibre.

Within sensor **201**, a set of conductive tracks is located upon each conductive textile layer. The conductive tracks **208**, **209** are metallised fabric, for example fabric coated with nickel or silver. Conductive tracks **208**, associated with conductive textile layer **206**, are configured to allow a voltage gradient to be established across the conductive textile layer **206** in a first direction across the sensor **201**. Similarly, conductive tracks **209**, associated with conductive textile layer **207** are configured to allow a voltage gradient to be established across the conductive textile layer **207**, but in a second perpendicular direction across the sensor **201**.

The final layer in the assembly is a partially insulating mesh separator layer **210**. The term mesh is used to refer to a layer defining a plurality of apertures therein. This layer is configured to space the conductive textile layers **206**, **207** apart when no pressure is applied to the sensor **201** and to allow electrical contact between the layers **206**, **207** therethrough during a mechanical interaction.

Of the layers in the assembly of sensor **201**, top mask **202** and base mask **204** have the greatest border dimensions. Intermediate mask **203** has smaller border dimensions and conductive textile layers **206**, **207** and separator layer **210** are of the same or smaller dimensions such that the conductive textile layers **206**, **207** and the separator layer **210** are dimensioned to fit within the border region around the window of intermediate mask **203**.

Figure 3

The arrangement of the conductive tracks **208**, **209** of sensor **201** with respect to neighbouring layers is illustrated in *Figure 3*.

Figure 3 shows a first subassembly **301** comprising top mask **202**, conductive textile layer **206** and conductive tracks **208**, and a second subassembly **302** comprising base mask **204**, conductive textile layer **207** and conductive tracks **209**. It can be seen that in each subassembly, the conductive tracks run from the electrical connection mounting tab around on the mask and then from the mask directly onto the conductive textile layer. In this example, the tracks are positioned one on each of opposite sides of the conductive textile layer. Thus, the masks each function as a substrate for portions of the conductive tracks.

Figure 4

An assembly technique to assemble the component layers of sensor **201** is illustrated in *Figure 4*. The orientation of top mask **202** is such that adhesive side **401** is facing downwards towards base mask **204**, and the orientation of both intermediate mask **203** and base mask **204** is such that the adhesive side of each, **402** and **403** respectively, is facing upwards towards top mask **202**.

With this arrangement, under the application of heat and pressure, base mask **204** bonds to intermediate mask **203**, as indicated by arrow **404**, encapsulating second conductive textile layer **207** and second conductive tracks **209** therebetween. Similarly, intermediate mask **203** and top mask **202**

bond together, indicated by arrow **405**, encapsulating first conductive textile layer **206**, first conductive tracks **208** and separator layer **210** therebetween. Due to the border dimensions of top mask **202** and base mask **204** being greater than that of the other component layers, top mask **202** and base mask **204** bond together, indicated by arrow **406**. This action seals the layers together into a layer assembly.

The masks of a layer assembly may provide more than one of the following functions: to provide insulation to prevent unwanted electrical contact within the assembly and/or to bond layers together and/or to provide a substrate for other components within the assembly and/or to protect the sensor against ingress of moisture or other contaminants and/or to provide an additional non-conductive area outside the sensing area of the sensor to allow, for example, the sensor to be physically connected to a case or other device.

To facilitate mounting of the sensor for use, for example by stapling to a base element, it is convenient for the sensor to have an extended, and in this example inactive, border around the edge of the sensor. To provide a stiff, robust edge, the footprint of the separator layer is extended beyond that of the conductive textile layers. The base mask and top mask then attach to each other through the separator layer during assembly.

In an alternative embodiment of the sensor, the top mask and the bottom mask each define an aperture, or window. This feature allows the sensor to breathe. According to a variant embodiment, the intermediate mask defines a plurality of apertures in place of a single window.

Alternatively, or in addition, one or more of the masks in the sensor

has adhesive on both sides thereof. According to an embodiment of the sensor, the intermediate mask has adhesive on both sides thereof. This facilitates assembly of the component layers. In a further alternative embodiment of sensor, the top mask and base mask each have adhesive on both sides thereof. This feature facilitates the assembly of the sensor into another assembly, for example a car door panel.

It is to be appreciated that textile layers are prone to fraying following cutting, therefore appropriate allowances should be incorporated into the production of the sensor. A fraying tolerance should be assigned to the conductive textile layers and to the conductive tracking, and the fraying tolerances should be taken into account when organising these layers on a mask.

A practical application for such a sensor is a strip sensor used with a chair having a motorised moving component mechanism. The sensor is attached to the leading edge of the moving component, which may be located on the underside of the motorised chair, and is configured to provide input data to the motor control of the moving component mechanism. This arrangement provides a safety function to prevent the mechanism closing on an obstacle, such as an animal or a child. In a safety mode of operation, the sensor detects an obstacle in the path of the moving component and the motor control responds to stop movement of the moving component continuing in the same direction, to prevent crushing or trapping of the obstacle.